hymns to the weapons of Indra, that animal bones were used among the early peoples of the East for purposes of offence and defence.—Continuation of Dr. Seeland's notes on Kashgaria and the passes of the Tian-shan. The author's description of the city of Kashgar, which lies on an extensive elevated plateau 3750 feet above the level of the sea, shows that the spot described in such glowing terms by Marco Polo is now nothing more than a confused network of foul, narrow, and tortuous streets, the houses of which lack every requirement of comfort, and almost of decency, as judged by our notions. The dwellings of the richer people have indeed large gardens filled with luxuriant fruit-trees, but the modern traveller would seek in vain for the shady groves, sparkling fountains, splendid mosques, spacious baths, rich bazaars, and lovely women, spoken of by the old Venetian writer. The ethnic type of the Kashgarians is clearly that of a deteriorated mixed race, in which the original Aryan or Turkish character has been nearly obliterated by repeated admixture with different Mongol races. The Chinese officials, under whose rule the people have long languished, effectually prevent all improvement in the country or the people, as is sufficiently shown by Dr. Seeland's account of the mode in which they govern this once fertile region. Indeed, nothing can be more deplorable than the account given of the personal appearance, character, and sociology of the Kashgarians, who exhibit the most marked slovenliness and incapacity, with a melancholy and passive temperament; and whose only pleasures are derived from an excessive abuse of narcotics, accompanied by a marked degree of sexual depravity, which they have possibly acquired through their intimate association with the Chinese. It fact, honesty seems to be the only virtue left to the Kashgarian. The account given by the author of the effect of Chinese rule in this part of Asia Minor agrees with the views of the late M. Prjevalsky, and certainly seems to warrant the conviction cherished by these travellers that the only apparent chance of ameliorating the condition of the people would depend upon the annexation of Kashgaria to the Russian Empire.—The race of Lagoa Santa of Brazil, by Dr. Soren Hansen. The bones found by M. Lund in the caves of Lagoa Santa were mostly deposited in one of these numerous recesses. These human remains were not associated with any animal bones, from which it could be determined with absolute certainty whether they were contemporaneous with a Tertiary or a Quaternary fauna, while the absence of every kind of implement left the antiquity of the race equally uncertain. These remains, which include fifteen more or less entire skulls, besides a very large number of bone fragments belonging to persons of all ages, are preserved in the Zoological Museum of Copenhagen. All the crania present remarkable uniformity with two skulls, respectively preserved in the British Museum and at Rio, which have been referred by M. Quatrefages to a Papuan type, and they appear to give support to his opinion of the existence over the greater part of South America of a primitive dolichocephalic race, which was subsequently intermingled with peoples presenting a brachycephalic character.

Notes from the Leyden Museum, vol. xi. No. 1, January 1889, contains twenty articles, chiefly descriptions of new genera and species of insects. The more important entomological papers are: Dytiscidæ et Gyrinidæ nouveaux ou rares, par M. Régimbart; Neue Coleopteren, beschrieben von E. Reitter; and a note on *Macronota apicalis*, G. and P., by J. R. H. Neervoort van de Poll.—There are two interesting papers by Dr. R. Horst, on a remarkable Syllis bud, with extrudible segmental organs (plate 1); and contributions towards a knowledge of the Annelida Polychæta (plate 2). This latter note, treats about the species of the genus Arenicola found at Naples: these are *A. claparedi*, Levinsen, possibly peculiar to the Mediterranean, but should be looked for on our southern coasts; *A. cristata*, Stimpson, originally described from South Carolina, but now found at Naples; *A. grubii*, Claparède, very common in the Gulf of Naples.—Dr. F. A. Jentink gives notes on a collection of mammals from East Sumatra, based on the collections made by Dr. B. Hagen. The orang-utan is to be found along the coasts of the northern half of East and West Sumatra, and among the other mammals, hitherto not recorded from Sumatra, though known to occur in Borneo, are *Arctogale stigmatica*, *Hemigalea derbyana*, *Herpestes brachyurus*, *Cynogale bennetti*, *Ptilocercus lowii*, and *Rhizomys dekan*.—Mr. J. Büttikofer gives notes on a new collection of birds from South-Western Africa (plate 4). The collection was made at Gambos, in the Upper Cunene region; it contained 267 skins, representing 103 species, of which number 49 were not mentioned in Mr. Büttikofer's previous list; two species are new, *Lophocercs alboterminatus* and *Francolinus jugularis*.

THE longer papers in the *Nuovo Giornale Botanico Italiano* for January are almost entirely floristic, relating to the phanerogamic or cryptogamic flora of particular districts of Italy.—Signor G. Arcangeli describes a remarkable monstrosity of *Narcissus Tazzetta*, in which the "corona" is divided into six petaloid leaves.—In the Reports of the meetings of the Societa Botanica Italiana, the same botanist follows up his account of the structure of the seed of *Euryale ferox* by a description of those of our common water-lilies, *Nymphæa alba* and *Nuphar luteum*. They all agree in the occurrence of a scanty endosperm, consisting of from one to four layers of cells, and a very copious perisperm.—Signor R. Pirotta describes the mode of fertilization of *Amorphophallus Rivieri*, which is effected almost entirely by a number of different species of Coleoptera.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 15, 1888.—"Observations upon the Electromotive Changes in the Mammalian Spinal Cord following Electrical Excitation of the Cortex Cerebri. Preliminary Notice." By Francis Gotch, Hon. M.A. Oxon., B.A., B.Sc. Lond., and Victor Horsley, B.S., F.R.S., Professor of Pathology, University College, London. (From the Physiological Laboratory of the University of Oxford.)

Hitherto pathologists have attempted the analysis of the epileptic convulsion by the graphic method—that is, by recording the spasmodic contractions of the muscles involved. Recent investigations of this kind have shown that the excitation of the cortex cerebri, whether by electrical or chemical means, or by the presence of certain pathological states, neoplasms, inflammation, &c., is invariably followed in the higher mammals by a definite and characteristic sequence of movements in the muscles. It is, however, obvious that such investigations have up to the present succeeded in determining the characters of the neural disturbance only when this has reached the peripheral terminations of the efferent nerves. Now since the excitatory processes originating in the cortex are conducted by the efferent channels in the spinal cord, presumably the pyramidal tracts, the problem of their relationship to the centres of the bulbo-spinal system cannot be determined by experiments which record the mechanical changes in the muscles. In order to ascertain what share respectively the centres in the cortex and those in the spinal cord have in the production of the characteristic epileptic sequence, the action of the latter must be eliminated. This can be done by investigating the nature of the excitatory processes in the cord when the efferent channels in the dorsal region for the lower limbs are made the subject of observation.

For this purpose we determined to obtain, if possible, evidence as to the nature of the excitatory processes of the epileptic convulsion in the spinal cord, as shown by "tapping" the cord and noting the electromotive changes which, as is well known, accompany functional activity in nerves. The results we have already obtained are so harmonious and demonstrative, that we venture to make this preliminary communication, reserving full details for a subsequent account.

PART I. *The Electromotive Change following a Single Excitation of the Mammalian Nerve.*

Our first experiments were made for the purpose of ascertaining to what extent we could detect an electromotive change following a single excitation of a mammalian nerve. Since the discovery by du Bois-Reymond of the fact that the excitatory process in nerve is accompanied by an electromotive change, the characters and time relations of this change have been investigated by various observers, notably by Bernstein, Hermann, Hering, and Head. The general result of their observations is to show that the change following a single stimulus is of very short duration, so short that the galvanometer gives little evidence of its presence, and the observers referred to were compelled to adopt the device first employed by Bernstein, which involves repeated excitation and consequent summation of effect, a method well known to physiologists as that of the repeating differential rheotome. For our purpose it was essential to obtain evidence of the effect following one stimulus only, and this we were fortunately able to do by using a sensitive Lippmann's capillary electrometer of quick reaction, made by Mr. G. F. Burch, and belonging to Dr. Burdon Sanderson, who kindly placed it at our disposal. This instrument, when the capillary was magnified 400 times by the observing microscope, gave a perceptible response when connected through a resistance of 10,000 ohms for one-thousandth of a second with an electromotive difference of only 0·003 D. The amount of movement of the mercury was estimated by the divisions of a micrometer eye-piece, one division of which indicated an actual movement of $\frac{1}{400}$ of a millimetre. After we had found that the electrometer, when connected with the transverse and longitudinal surfaces of the sciatic nerve of the toad, showed a response of one division following the application of a single stimulus, whether electrical or mechanical, we proceeded to the examination of the sciatic nerve in the rabbit, cat, and monkey. For these experiments the animal was in every case kept under the influence of ether, which was maintained throughout the whole experiment, and the animal was killed before recovery. The sciatic nerve seemed for many reasons the most suitable of the mammalian nerves. It can be quickly prepared for 7 or 8 cm. of its length, its nutrition is well preserved, since the *arteria comes nervi ischiadici* can be left uninjured, and its diameter lessens the dangers of drying.

The nerve, having been rapidly prepared and bathed in warm saline solution, 0·6 per cent., was ligatured low down in the thigh, the ligature including the popliteal trunks. It was then divided on the peripheral side of the knot, and raised in air so as to be at right angles to the limb. One kaolin pad of a non-polarizable electrode was applied to the cut end, and another to the longitudinal surface at a distance of 1·5 cm. A pair of sheathed exciting platinum electrodes, 2 mm. apart, was then applied to the trunk of the nerve 6 cm. centrally from the nearest leading-off electrode, *i.e.* opposite the sciatic notch. The exciting stimulus was obtained by the break of the current of a single Callaud cell supplying the primary coil of a du Bois-Reymond inductorium graduated by Kronecker. The break shock produced in the secondary coil by this means was so feeble as to be barely perceptible on the tip of the tongue when the secondary coil completely covered the primary. The break was effected by the spring rheotome, which opened a fixed key at a definite point in its course. The electrometer was connected with the non-polarizable electrodes by a circuit which included the usual compensator. By means of a switch the electrometer could be cut out, and the circuit made to include a high resistance galvanometer, which also revealed the single variation. The two instruments could be thus readily compared. The excursion of the mercury of the electrometer was ascertained both by direct observation in terms of the divisions of the micrometer eye-piece, and by photographing the projected capillary upon a moving sensitive plate; in the latter case the capillary was magnified 100 times. The results of our observations are briefly as follows:—

The mammalian nerve showed a well-marked difference or demarcation current—that is to say, the electrode upon the longitudinal surface was notably positive to that on the cut end. The movement of the mercury corresponding to this difference amounted in some cases to 60 divisions of the micrometer, and was produced by an electromotive force which was estimated as from about 0·01 to 0·015 D. The passage of the single break induction shock through the platinum electrodes in either direction was followed by a small quick movement of the mercury, which was invariably in the opposite direction to that produced by the demarcation current. Its amount varied in different animals from 1 to 2·5 divisions of the micrometer eye-piece, and was photographed. After severing the nerve from the bulbo-spinal system above the exciting electrodes, the same effect was obtained; its character, as shown by the movement of the mercury, was, however, different, being as we believe much shorter in duration and less in amount. But, our experiments not being directed to the elucidation of this point, we will not speak positively with regard to it. After a time, varying in different cases from twenty minutes to three-quarters of an hour, the effect was no longer visible. We convinced ourselves that the movement we obtained and photographed was due to the electromotive change which accompanies the propagation of an excitatory state along the mammalian nerve when this state is evoked by the application of a single stimulus.

PART II. *Excitation of the Cortex Cerebri.*

A. *Mixed Spinal Nerve connected with the Electrometer.*—In two cases we have connected in the manner described in Part I. the sciatic nerve with the electrometer, and have then exposed by a small trephine opening the so-called motor cortical centre for the lower limb. This we then excited by a very weak but adequate faradic current. So far, however, we have not been able to detect any movement in the mercury, although the muscles of the investigated limb supplied by the anterior crural nerve were thrown into a state of active convulsion. It is probable that the character of the neural disturbances in the mixed nerve may be best studied by investigations which we shall shortly undertake upon the electromotive changes in the muscles.

B. *The Spinal Cord connected with the Electrometer.*—The experiments, the results of which are now to be briefly detailed, were made in the following manner:—

The spinal cord of the etherized animal (cat and monkey) was exposed in the lower dorsal region for about 4 cm., and as low down as the upper end of the lumbar enlargement. Great care was taken by bathing with warm saline to guard as much as possible against the dangers of error due to cooling and drying. The dura mater having been split longitudinally, a strong thread was passed round the spinal cord at the lower limit of the part exposed. It was tied firmly and the cord divided below the knot. By successive division of the two or three roots exposed in the intervertebral foramina, the cord was easily raised from the neural canal and suspended in the air without any great interference with the circulation in the longitudinal vessels.

One of the non-polarizable electrodes was then brought into contact with the cut end of the cord and the knotted ligature, while the other was connected with the longitudinal surface of the cord 2 cm. from the cut end by means of soft thread cables soaked in saline solution and tied loosely round the cord. In one experiment the connection was with one lateral column only. Mass movements of the electrodes upon the spinal cord were suitably guarded against, though it was found that the cord might be shaken without producing any effect in the electrometer.

On connecting these electrodes with the electrometer a considerable electromotive difference was found to exist between the contacts, the excursion of the mercury being so great, *i.e.* beyond the field of the microscope, that its amount could not be estimated in terms of the micrometer eye-piece. The cut surface was always negative to the longitudinal surface, and the amount of the difference as estimated by the compensation method was about 0·02 D. It appeared to be highest when the section passed through the dorsal region without involving the lumbar enlargement. A difference between the surfaces of the cord has been previously observed by du Bois-Reymond.

The cortex cerebri was now exposed and the exciting circuit prepared. The inductorium previously employed was again used with one Daniell cell in connection with the interrupter of primary coil and the Helmholtz side wire. The exciting electrodes had platinum points 2 mm. apart.

The demarcation current having been compensated, and the electrometer placed in connection with the non-polarizable electrodes, the motor area for the lower limb was excited. The results of the observations made upon four monkeys and several cats may be summed up as follows:—

(1) The application of the exciting electrodes to the cortex was without exception only followed by a movement in the electrometer when the area of representation of the lower limb was touched, and this even when owing to prolonged excitation of the arm area the upper limb was in violent epileptic convulsion. We found that when the exciting electrodes were moved over the surface of the brain the observer at the electrometer only gave notice of a movement in the instrument when the person exciting had crossed the margin of representation of the limbs. This shows that electromotive changes in the cord sufficient to affect our instrument occurred only when the motor area of the lower limb was excited. All error due to escape is thus set on one side, while at the same time this remarkable fact confirms the localization of function.

(2) The excitation of the motor area for the lower limb was accompanied and followed by characteristic movements of the mercury. The excitation by means of the interrupted current usually lasted for three seconds—that is, about 300 equal and alternately directed induction currents passed through the excited tissue. During this period the mercury showed an excursion opposed in direction to that of the difference between the longitudinal surface and cut end of the cord. This excursion persisted as long as the excitation lasted, and ceased when this was left off. Then after an interval of from one to three seconds there ensued a rhythmical succession of excursions each opposed

in direction to the resting difference, some apparently single and others multiple. These lasted from twenty to thirty seconds and suddenly ceased.

We have repeated this observation thirty or forty times, and feel ourselves justified in concluding that we have obtained evidence that during a cortical epileptiform discharge the electromotive changes in the spinal cord are exactly parallel as regards the character of their sequence to the convulsions of the muscles as recorded by the graphic method. It remains to be stated that after removal of the cortex we have obtained an effect in the electrometer when the corona radiata was stimulated. This effect was only present during the period of excitation, no rhythmical after effect ever being observed. Its character was prolonged, and resembled the first persistent stage referred to above.

In conclusion, we consider that, since by the method we have adopted the influence of the lumbar bulbo-spinal centres is excluded, the existence of the epileptic rhythm in the dorsal regions of the spinal cord points to its being almost entirely of cortical origin.

Physical Society, February 23.—Prof. Reinold, President, in the chair.—Dr. J. W. Waghorne read a note on the measurement of electrical resistance, showing that two resistances may be compared by joining them in series with a battery, and observing the deflections of a galvanometer connected successively with their terminals. The resistances are proportional to the currents which pass through the galvanometer in the two cases, provided they are large compared with that of the battery, or are not very different from each other. By using a rocking key, the method is rendered expeditious, and the galvanometer resistance need not be known.—On a new polarimeter, by Prof. S. P. Thompson. The author gave a *résumé* of the ordinary methods of determining the position of the plane of polarization, pointing out their advantages and disadvantages; and exhibited his new polarimeter, in which two black glass mirrors, placed at a small angle (about 2½°), are used to polarize the light in two different planes. By using a modified Nicol as analyzer, the plane can be determined to one-tenth of a degree, when the substance examined does not absorb much light; but, for dark-coloured liquids, the author prefers to use one of his "twin prisms," described before the British Association in 1887, as polarizer, in which the planes of polarization are 90° apart. A method of dividing a polarized beam into two parts inclined at a variable angle, by means of a combination of quarter-wave plates of mica, was described, in which the two halves of the field are similarly coloured. Mr. Glazebrook considered Poynting's glass cell, with different thicknesses of active solution, a very convenient means of obtaining two beams polarized at a small angle, as, by altering the strength of the solution, the angle may be varied at will.—Prof. Thompson also read a note on the formation of a cross in certain crystal structures. Several specimens (including benzoic acid, stalactite, Eno's salt, &c.), which exhibit a radial structure, and show a cross when examined by polarized light, were thrown upon the screen, and the fact that the cross remains stationary when the specimens are rotated demonstrated. Similar effects were produced by mica sectors arranged radially, thus showing the stationary cross to be caused by the light not being analyzed in those directions.—On electrical measurement, by Prof. W. E. Ayrton, F.R.S., and Prof. J. Perry, F.R.S. In a paper on winding voltmeters, read before the Society in 1885, the authors showed, on the assumption that the thickness of insulating covering on wires was proportional to their diameter, that instruments wound with copper wire gave a less heating error than similar ones wound with German silver. Since then, platinoid has been introduced, and the electrical constants of phosphor-bronze determined. Further, a remarkably simple relation between the volts corresponding to a given deflection on a given type of instrument, and the resistance per unit length of the wire used in winding it, has been suggested by Mr. Crawley. Suppose F = number of ampere turns required to produce the deflection P, and U the half area of section and volume of the coil respectively, and d and D the diameters of the bare and covered wires, then—

$$A = \frac{F}{n},\ n = \frac{P}{D^2},\ r = \frac{4l\rho}{\pi d^2},\ \text{and}\ l = \frac{U}{D^2};$$

from these we get—

$$V = Ar = \frac{FU}{P} \cdot \frac{4\rho}{\pi d^2} = K \cdot \frac{4\rho}{\pi d^2},$$

(say) where K is a constant depending on the type of instrument. Since $\frac{4\rho}{\pi d^2}$ is the resistance per unit length, *the volts required to produce a given deflection are proportional to the resistance per unit length of the wire used, whatever be the material of the wire or thickness of the insulation.* Taking this into account, and using a more accurate value for the thickness of the covering, it is shown that the four metals above referred to arrange themselves in the following order of merit when used for high-reading voltmeters—platinoid, phosphor bronze, german silver, and copper; and for comparatively low-reading instruments, the last two change places. As a standard ammeter of great range, a circuit containing a Depretz D'Arsonval galvanometer is shunted by a wide sheet of thin platinoid, and by altering the resistance in the galvanometer circuit, the sensibility may be varied in known proportions. An instrument on this plan has been arranged to measure any current from 0·1 to 800 amperes to one-quarter per cent., and the same galvanometer in series with various resistance coils is used as a standard voltmeter of practically unlimited range. Whilst arranging these standards it has been found that the deflections are not generally proportional to the currents, and the discrepancy traced to the centre of gravity of the swinging coil not being in the line of suspension. By replacing the bottom torsion wire by a long thin spring the defect may be remedied. As relating to calibration curves of instruments, it was mentioned that in "Siemens's dynamometer" the "square law" is not correct, probably owing to distortion of the spring. Referring to "hot wire voltmeters," in which the sag of a wire heated by the current is measured by a magnifying spring, the authors remark that, in their original paper on the subject, they neglected the change of length due to change of stress in the wire, and subsequently their assistant, Mr. Bourne, found that maximum sensibility was never co-existent with minimum sag. The sag which gives maximum sensibility depends on the initial stress in the wire, and by altering the initial sag the instruments may be compensated for changes of temperature of the room. In the present paper the mathematical treatment is more rigorous, and the results are in accordance with experiment. A voltmeter intended for use with "electric welders," which deflects about 300° for 2 volts (direct or alternating), and is graduated to 1/100 of a volt, was exhibited, and used to measure the resistance of a storage cell. Dr. Thompson suggested that the want of proportionality of D'Arsonval galvanometers might be due to lateral displacement of the coil caused by the current in the torsion wires crossing a magnetic field, but from experiments with pivoted coils the authors thought this improbable.—Prof. Rücker read a note on the dimensions of electro-magnetic units, by Prof. G. F. Fitzgerald, F.R.S., which suggests that specific inductive capacity and permeability be *assumed* to be of dimensions $\left[\frac{T}{L}\right]$ (slowness); if this be done the dimensions of quantities expressed in electrostatic and electro-magnetic measure become identical. The author also states that it seems most likely that inductive capacities are related to the reciprocal of the square root of the mean energy of turbulence of the ether. Prof. Rücker remarked that in his recent paper on the subject he considered it important to retain K and μ as secondary fundamental units, and Mr. Blakesley did not concur with Prof. Fitzgerald's suggestion.—A photograph of crystal models, by Mr. R. T. Anderson, of Belfast, was exhibited at the meeting.

Chemical Society, February 21.—Mr. W. Crookes, F.R.S., in the chair.—The following papers were read:—Note on the decomposition of potassic chlorate by heat in the presence of manganic peroxide, by Prof. H. McLeod, F.R.S. The author concludes from his experiments that the reaction which ensues when potassic chlorate is heated with manganic peroxide most probably consists in the formation of potassium permanganate chlorine, and oxygen in the first instance; that the permanganate as rapidly as it is produced is decomposed by the heat into potassic manganate, manganic peroxide, and oxygen; and that the resulting potassic manganate is acted on by chlorine generated by the action of the peroxide on some fresh chlorate, forming potassic chloride, manganic peroxide, and oxygen, so that the peroxide is being continually reproduced. The quantity of chlorine evolved corresponds to only a very small proportion of the manganic peroxide present, so, if the first action really takes place, the chlorine must be absorbed and employed in converting the potassium into chloride.—The vapour-density of hydrogen fluoride, by Prof. T. E. Thorpe, F.R.S., and Mr. F. J. Hambly. Gaseous hydrogen fluoride, on being heated from a few degrees above the boiling-point of the liquid, shows a rapid decrease in density, owing to the dissociation of H_xF_x molecules ultimately into HF molecules, the course of the dissociation being similar to that observed in the case of nitrogen peroxide and acetic acid. The density of the gas at about 32° corresponds with that required for a molecule H_2F_2, but a careful study of the molecular breaking down of the vapour as it is effected by changes of temperature and pressure shows that there is no evidence for the existence of such a molecule. At a temperature of 26°·4, the lowest temperature observed, the density of the gas corresponds with a molecular weight of 51·2 ($H_3F_3 = 60$), and from this point the process of dissociation is perfectly continuous until the temperature increases to about 60°, when the density corresponds with that of a vapour consisting wholly of HF molecules. In the discussion which followed the reading of the paper, Prof. Ramsay said that Prof. Thorpe, in speaking of the analogy of the results obtained in the case of hydrogen fluoride with those of the brothers Natanson for nitric peroxide, had pointed out that these latter afforded insufficient proof of the higher limiting value of n in the formula N_nO_{2n}; and that this limiting value was also unknown in the case of acetic acid, of which the vapour-density also increased with fall of temperature. Now there were three separate lines of argument leading to a knowledge of the higher limiting formulæ of these bodies which had been pointed out by himself and Dr. Young, and of which the data were to be found in papers published in the Philosophical Transactions, in the *Philosophical Magazine*, and in the Chemical Society's Transactions. The first of these has reference to the alteration of density of the saturated vapour with fall of temperature and corresponding fall of pressure. It is argued that the density of the vapour of a substance must necessarily, at any given temperature, be higher when the vapour is on the point of condensation than when it is unsaturated. Hence, if it can be proved that the density of the saturated vapour of bodies like nitric peroxide and acetic acid shows no signs of increasing beyond those required for the respective formulæ N_2O_4 and $C_4H_8O_4$, such formulæ must denote the limit of complexity of the molecules, in the gaseous state at least. To ascertain such a limit, Dr. Young and the speaker constructed from the Natansons' data for the relations of volume, pressure, and temperature of nitric peroxide, and their own data for the vapour-pressure of that body, isothermal curves in which pressures formed ordinates and vapour-densities abscissæ. The terminal points of such curves are characterized by rapid increase of density without rise of pressure, and, in fact, denote that the substance is no longer in the gaseous state, the vapour-pressure of the liquid having been reached. The densities of the saturated vapour therefore will correspond with the angles of union of the isothermal curves with horizontal straight lines representing condensation to liquid under vapour-pressures constant for each temperature. By joining with each other such angles of union for each temperature a curve is obtained expressing the densities of the *saturated* vapour in relation to pressure. It is evident from inspection of such a curve for acetic acid, shown in a plate in the Transactions of the Chemical Society, 1886, 806, that the line of zero-pressure would be cut at the density 60, corresponding with the formula $C_4H_8O_4$; a similar curve can be constructed from the Natansons' results and Ramsay and Young's determinations of the vapour-pressures of nitric peroxide, and this intersects the line of zero-pressure at a point corresponding with the vapour-density 92, equivalent to the formula N_2O_4. The second argument is as follows: Representing the relations of temperature and pressure of a "perfect" gas for any given constant volume, $p = c \, . \, t$, where c is a constant and t absolute temperature. This is the equation to a straight line; such a line is termed an *isochoric line* or *isochor;* its point of origin for a perfect gas is absolute zero of pressure and temperature. If a different volume be chosen, the slope of the line is different. Now it is clear that if a given volume of gas contains $2n$ molecules, pressure will rise with rise of temperature at twice the rate that it would if the given volume of gas contained n molecules. Constructing for nitric peroxide and for acetic acid, on the assumption that they are perfect gases, diagrams showing the relations of pressure and temperature for the formulæ NO_2 and $C_2H_4O_2$ at such volumes that 1 gramme occupies, say, 1000 c.c. in each case, the resulting straight lines will manifestly differ in slope from those corresponding to the respective formulæ N_2O_4 and $C_4H_8O_4$, the pressure in the latter case not rising so rapidly with rise of temperature owing to the smaller number of molecules in that volume. But we know that the actual behaviour of these bodies is not that of perfect gases. The line representing the relations of pressure and temperature, should at high temperatures, when the substances exist in the molecular states NO_2 and $C_2H_4O_2$, nearly coincide with the theoretical line for these molecular states; and at low pressures and temperatures with the line denoting the molecular condition N_2O_4 and $C_4H_8O_4$. The data of actual experiment show that such is the case. The S-shaped isochoric curve trends so that it is probable that it would become tangential with that expressing the behaviour of molecules of the higher formulæ, showing no signs of cutting it as it must needs do were still more complex molecules capable of existence. The third line of argument is derived from the application of Raoult's method to a solution of nitric peroxide in acetic acid, and the results obtained show that the molecular weight corresponds closely with the formula N_2O_4.—Contributions to the chemistry of lignification: the constitution of the jute fibre substance, by Messrs. C. F. Cross and E. J. Bevan. The authors describe the results of a fuller study of the lignocelluloses (cf. Chem. Soc. Trans., 1882, 90; 1883, 18).—The atomic weight of chromium, by Mr. S. G. Rawson. The atomic weight of chromium, as determined by converting a known weight of ammonium bichromate into chromic oxide, is found to be 52·061.

Linnean Society, March 7.—Mr. Carruthers, F.R.S., President, in the chair.—Mr. J. E. Harting exhibited specimens of a South American Bat (*Noctilio leporinus*) alleged to be of piscivorous habits, and which, through the kindness of Sir William Robinson, the Governor of Trinidad, had been forwarded from that island by Prof. McCarthy, together with a Report on the subject. From this Report, it appeared that the stomach of one specimen, opened within half-an-hour after it had been shot on the evening of December 29, "contained much fish in a finely-divided and partially-digested state." In three others procured at 6 a.m. the following morning, the stomachs were empty. On the morning of December 31, at 3 a.m., numbers of these bats were observed returning to their caves: two were shot, and "both contained considerable quantities of fish." Prof. McCarthy added that in the stomachs of other specimens examined by him fish scales were undoubtedly present. Of the specimens forwarded in spirits to this country, two had been skinned and the stomachs and intestines examined by Mr. Harting. The sac-like stomach was much less muscular than might be expected in a fish-eating mammal; but in one of them (the other being empty) fragments of a finely-striated and iridescent substance resembling fish-scales were found. A discussion followed, in which Prof. Howes and Mr. W. P. Sladen took part, the conclusion being that, although there was no *a priori* improbability in the alleged piscivorous habits of this bat, it could hardly be accepted as a fact until the fragments, supposed to be of fish, were really proved to be so by careful microscopical and chemical examination.—A paper was then read by the Rev. Prof. Henslow on the vascular systems of floral organs, and their importance in the interpretation of the morphology of flowers. The author drew attention to the importance of this class of observations, as supplementing development and teratology; for, by referring all organs back to their "axial traces," their real origins could generally be discovered. Taking the words metaphorically as "floral units," he explained how they can, as it were, give rise to axes as well as to all kinds of floral appendages. Quoting Van Tieghem's definitions of axial and foliar characters, the former was shown to be subject to exceptions. After describing the arrangements of the cords in peduncles and pedicels, in which endogens often have the cords as regularly placed as in exogens, the author explained the different ways by which pedicels and umbels are formed in each class respectively. The "chorism" and union of cords were illustrated and the effects produced. Considerable light was thrown upon the cohesion and adhesion of organs, and the interpretation of the "receptacular tube" and "inferior ovary" was shown to depend upon the undifferentiated state of the organs when in congenital union. The true nature of axile and free central placentas was revealed, so that in the case of the former, with scarcely any exception, the axis takes no part in the structure, all "carpophores," "stylopods," &c., being simply the coherent and hypertrophied margins of carpels. Similarly, the free central placenta of *Primula* received its interpretation as consisting of the coherent and ovuliferous bases of fine carpels which have the upper parts of their margins coherent in a parietal manner. Illustrative diagrams were exhibited of nearly seventy genera typical of about thirty orders. The paper was favourably criticized by Dr. D. H. Scott, Mr. A. W. Bennett, and Prof. Marshall Ward.

PARIS.

Academy of Sciences, March 11.—M. Des Cloizeaux, President, in the chair.—Fresh experiments with hydrogen peroxide and chromic acid, by M. Berthelot. In previous communications (*Comptes rendus*, vol. cviii. pp. 24 and 157) it was shown that the reactions between chromic acid and hydrogen peroxide also took place with bichromate of potassium, and that this salt has the property of gradually decomposing an unlimited quantity of hydrogen peroxide, remaining itself unchanged. This continuous reaction was attributed to the formation of an intermediate compound incessantly destroyed and renewed throughout the process of decomposition, and the experiments now described tend to confirm this phenomenon.—On the cephaloid organs in the tendons of birds, by M. Ranvier. The organs to which M. Ranvier has given the name of "cephaloid" are here fully described, and their presence determined in the domestic fowl, pigeon, and duck, but not in the lapwing. Where found they invariably present pretty much the same disposition and structure.—Actinometric observations made in 1888 at the Observatory of Montpellier by MM. Houdaille and Mazade, and reported by M. A. Crova. These observations confirm the general laws established by the records of previous years (1883-87), showing that, while the epochs of maximum and minimum intensities vary with the meteorological conditions, the great maximum always occurs in spring, and the secondary in autumn.—On the solar spots, by M. Spoerer. These remarks are made in connection with the author's recent memoir on the periodicity of the solar spots since 1618 (Hallé, 1889), in which the law anticipated by Carrington is definitely demonstrated and formulated. But although the norma for the distribution of spots in heliocentric latitude is established for many past periods, great aberrations are shown to have prevailed during the period between 1672 and 1713. After the reading of the paper, M. Faye pointed out that according to his own theory the spots depended, like the pores, not on irregular eruptions of a volcanic nature, but on the alimentation of the photosphere, an essentially stable process, or at least subject only to infinitesimally slight variations. In the general complexity of the phenomenon, the pores with the faculæ and cloudy protuberances appear to be the more stable elements, and the spots and metallic protuberances more of an accessory character.—On the value of the revolution of the right ascension screw in a meridian instrument, as determined by the observation of the equatorial or circumpolar stars, by M. G. Rayet. This inquiry shows that the determination of the value in question by observing the transit of a circumpolar is not more exact than that resulting from the observation of equatorial stars, and that when practised in the ordinary way, apart from the phenomena of refraction, it leads to systematic errors, that cannot be neglected in researches needing great accuracy.—On the automatic gauging of an artificial feeder, by M. H. Parenty. The method invented by the author, and described by him in the *Comptes rendus*, vol. civ. p. 1427, has been applied with complete success for estimating continuously and automatically the irregular discharge of the Courpalet feeder of the Orleans Canal, all efforts to calculate which had hitherto been baffled by the varying size of the cuttings, its winding course, and almost imperceptible fall.—On transformations and equilibrium in thermodynamics, by M. Gouy. The method already described in the *Comptes rendus* for February 18, 1889, leads to the use in thermodynamics of a new function, which is here described, and which appears to present the advantage of being directly connected with the consideration of cycles.—Relation between magnetic rotatory power and the transmission of luminous waves by ponderable matter, by M. A. Potier. Here an explanation is sought in the views of Fresnel of magnetic rotatory power in reference to Rowland's electromagnetic theory of light.—Employment of sulphite of sodium for developing the picture in photography, by M. Paul Poiré. Numerous experiments carried out by the author with a solution of sulphite of sodium and pyrogallic acid as a developing bath show that the best results are obtained when the sulphite is in the proportion of 25 per cent. with 1·5 gramme of pyrogallic acid added. The development is slower but more intense and clearer than when the sulphite contains carbonate, and the bath may be used repeatedly and preserved for months in corked bottles.—On the monochloracetoacetic ethers α and γ; synthesis of citric acid, by MM. A. Haller and A. Held. It has already been shown that W. James's cyanacetoacetic ether is identical with that obtained by the authors by treating sodium acetoacetic ether with cyanogen chloride. This view is here confirmed by a fresh synthesis of this cyanide, prepared by making acetyl chloride react on sodium cyanacetic ether.—Papers are contributed by MM. Ph. Barbier and J. Hilt, on australene; by M. A. Müntz, on the fertilizing properties of the Nile waters; by M. Aimé Girard, on the cultivation of the potato; by M. I. Straus, on preventive vaccination against glanders; by M. S. Arloing, on the zymotic effects of the soluble substances contained in the cultures of *Bacillus heminecrobiophilus*; and by M. A. Bottarel, on the poisoning apparatus found in certain fishes.

BOOKS, PAMPHLETS, and SERIALS RECEIVED

Carl von Linné's Ungdomsskrifter, vol. ii. (Stockholm, Norstedt).—Mechanics and Experimental Science: Heat and Light: Dr. E. Aveling (Chapman and Hall).—Mechanics and Experimental Science: Magnetism and Electricity: Dr. E. Aveling (Chapman and Hall).—Industrial Education: Sir P. Magnus (K. Paul).—Chambers's Encyclopædia; new edition, vol. iii. (Chambers).—Practical Plane and Solid Geometry; revised and enlarged edition: J. S. Rawle (Simpkin).—Practical Iron Founding (Whittaker). The Orbit of the Planet Sappho (80): R. Bryant (Waterlow).—A Text-book of Pathology, vol. i.: D. J. Hamilton (Macmillan).—The Elastical Researches of Barré de Saint-Venant: edited by K. Pearson (Cambridge University Press).—Agricultural Canada: Prof. Fream.—Report of the Rugby School Natural History Society, 1888 (Rugby).—Philosophy and Specialities: G. Mallery (Washington).—Nineteenth Annual Report of the Wellington College Natural Science Society, 1888.—Journal of the Chemical Society, March (Gurney and Jackson).—Anales del Museo Nacional de Buenos Aires, Entrega Decimaquinta (Buenos Aires).—Proceedings of the Royal Society of Edinburgh, vol. xvi. pp. 1–64.—Annalen der Physik und Chemie, 1889, No. 4 (Leipzig, Barth).

CONTENTS.

PAGE

Baku Petroleum. By **Prof. T. E. Thorpe, F.R.S.** . . 481
A Text-Book of Elementary Biology 482
United States Geological Survey 484
Our Book Shelf:—
  Rideal: "Practical Inorganic Chemistry" 485
  Newall: "Scottish Moors and Indian Jungles" . . 485
Letters to the Editor:—
  The Inheritance of Acquired Characters.—**Prof. E. Ray Lankester, F.R.S.; Prof. W. J. Sollas; J. Jenner-Weir** 485
  Hertz's Equations in the Field of a Rectilinear Vibrator.—**Rev. H. W. Watson** 486
  Alternative Path Leyden Jar Experiments.—**Prof. Oliver J. Lodge, F.R.S.** 486
  The Celluloid Slide-Rule.—**C. V. Boys, F.R.S.** . . . 486
  The Philosophical Transactions.—**H. R.** 486
  Japanese "Koji."—**R. W. Atkinson** 487
The Total Solar Eclipse of January 1. (*Illustrated.*) By **J. Norman Lockyer, F.R.S.** 487
The Gradual Rising of the Land in Sweden. By **Baron A. E. Nordenskiöld** 478
Variable Stars and the Constitution of the Sun. By **A. Fowler** 492
The Rabbit Pest. By **Dr. P. L. Sclater, F.R.S.** . . . 493
Notes 494
Our Astronomical Column:—
  Rowland's Photographic Map of the Normal Solar Spectrum 496
  The Clinton Catalogue 497
  Saturn's Ring 497
  The O'Gyalla Observatory 497
  Moon-culminating Stars 497
Astronomical Phenomena for the Week 1889 March 24–30 497
Geographical Notes 497
Sixth Annual Report of the Fishery Board for Scotland 498
Scientific Serials 499
Societies and Academies 500
Books, Pamphlets, and Serials Received 504